NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

September 19, 2013

Group Chairman's Factual Report

METEOROLOGY

DCA13MA120

Table Of Contents

A. ACCIDENT

Location: 8 miles southeast of San Francisco, California
Date: July 6, 2013
Time: approximately 1128 Pacific daylight time (1828 UTC[1])
Aircraft: Boeing 777-200ER, registration: HL7742

B. METEOROLOGY GROUP

Paul Suffern
Senior Meteorologist
National Transportation Safety Board
Operational Factors Division, AS-30
Washington, D.C. 20594-2000

C. SUMMARY

For a summary of the accident, refer to the *Accident Summary* report, which is available in the docket for this investigation.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist was not on scene for this investigation and gathered all the weather data for this investigation from the NTSB's Washington D.C. office and from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Climatic Data Center (NCDC). All times are Pacific daylight time (PDT) on July 6, 2013, and are based upon the 24-hour clock, where local time is -7 hours from UTC, and UTC=Z (unless otherwise noted). Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident location was located at latitude 37.61° N, longitude 122.36° W, elevation: 13 feet.

[1] UTC – is an abbreviation for Coordinated Universal Time.

E. FACTUAL INFORMATION

1.0 Synoptic Situation

The synoptic or large scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction (NCEP), and the Weather Prediction Center (WPC) located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. Reference to these charts can be found in the, joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC-0045G CHG 1.

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 1100 PDT is provided as figure 1, with the approximate location of the accident site marked. The chart depicted a stationary front in western Nevada stretched northeastward into western Wyoming. A surface trough[2] was located east of the accident site, stretched north to south in the Central Valley of California. The station models around the accident site depicted air temperatures in the low 50's to mid 60's Fahrenheit (F), with temperature-dew point spreads of 10° F or less, a south wind between 5 and 10 knots, and partly cloudy skies.

[2] Trough - An elongated area of relatively low atmospheric pressure or heights.

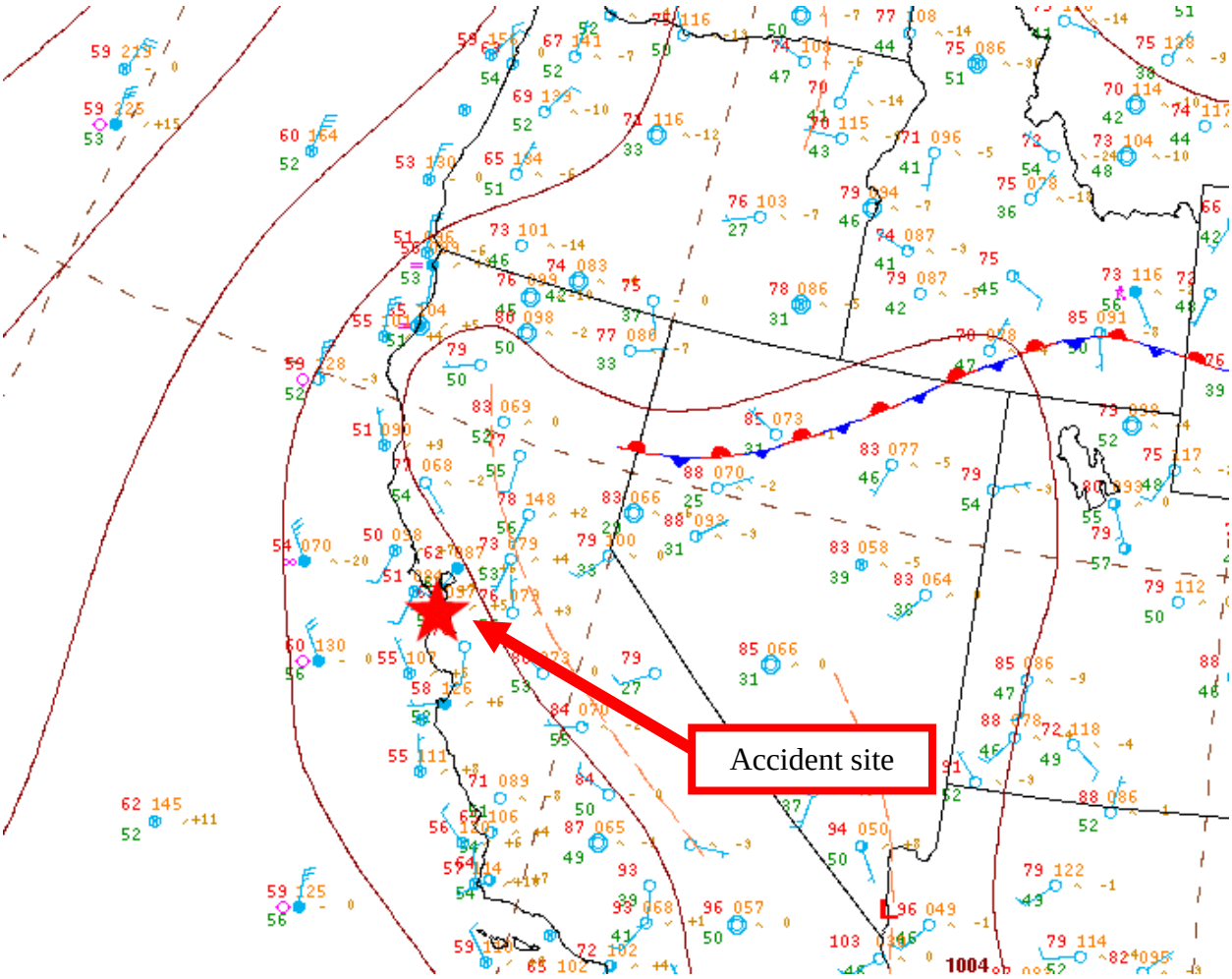


Figure 1 – NWS Surface Analysis Chart for 1100 PDT

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 1700 PDT at 925-, 850-, 700-, 500-, and 300-hectopascals (hPa) are presented in figures 2 through 6. The 925-hPa chart depicted a 15 knot southwest wind (figure 2) and the wind increased to 20 knots by 300-hPa (figure 6), with the wind remaining out of the west to southwest from 925-hPa to 300-hPa.

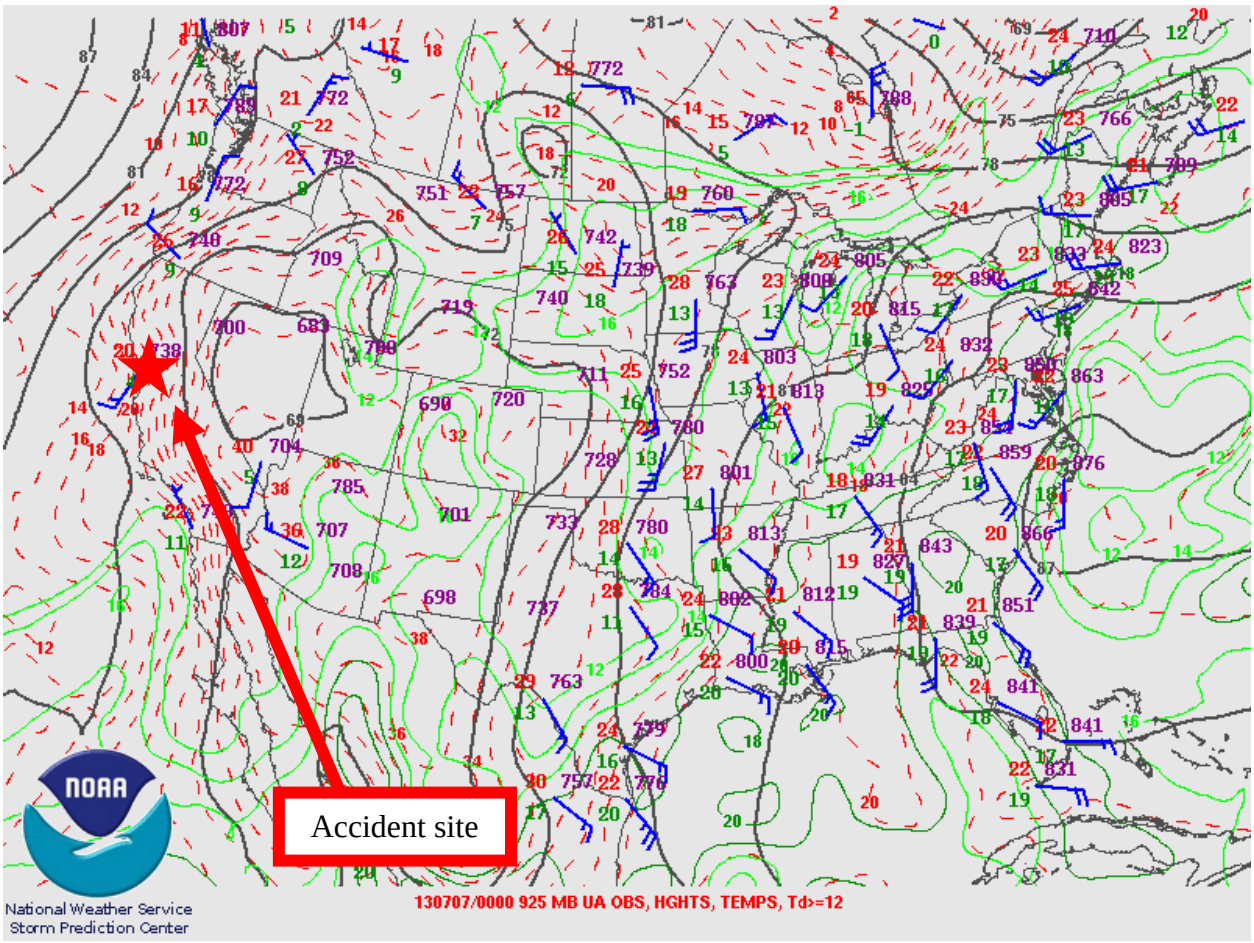


Figure 2 – 925-hPa Constant Pressure Chart for 1700 PDT

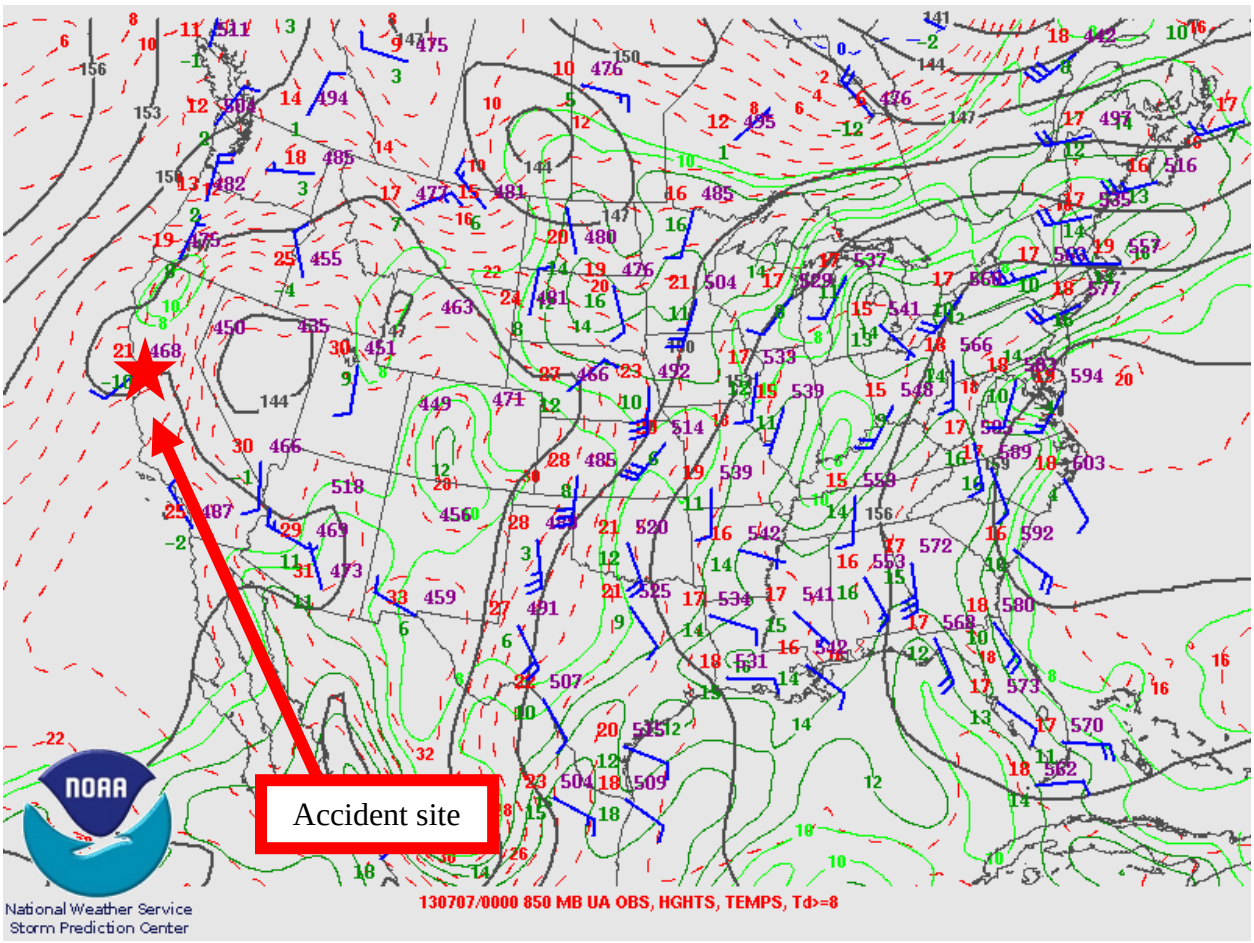


Figure 3 – 850-hPa Constant Pressure Chart for 1700 PDT

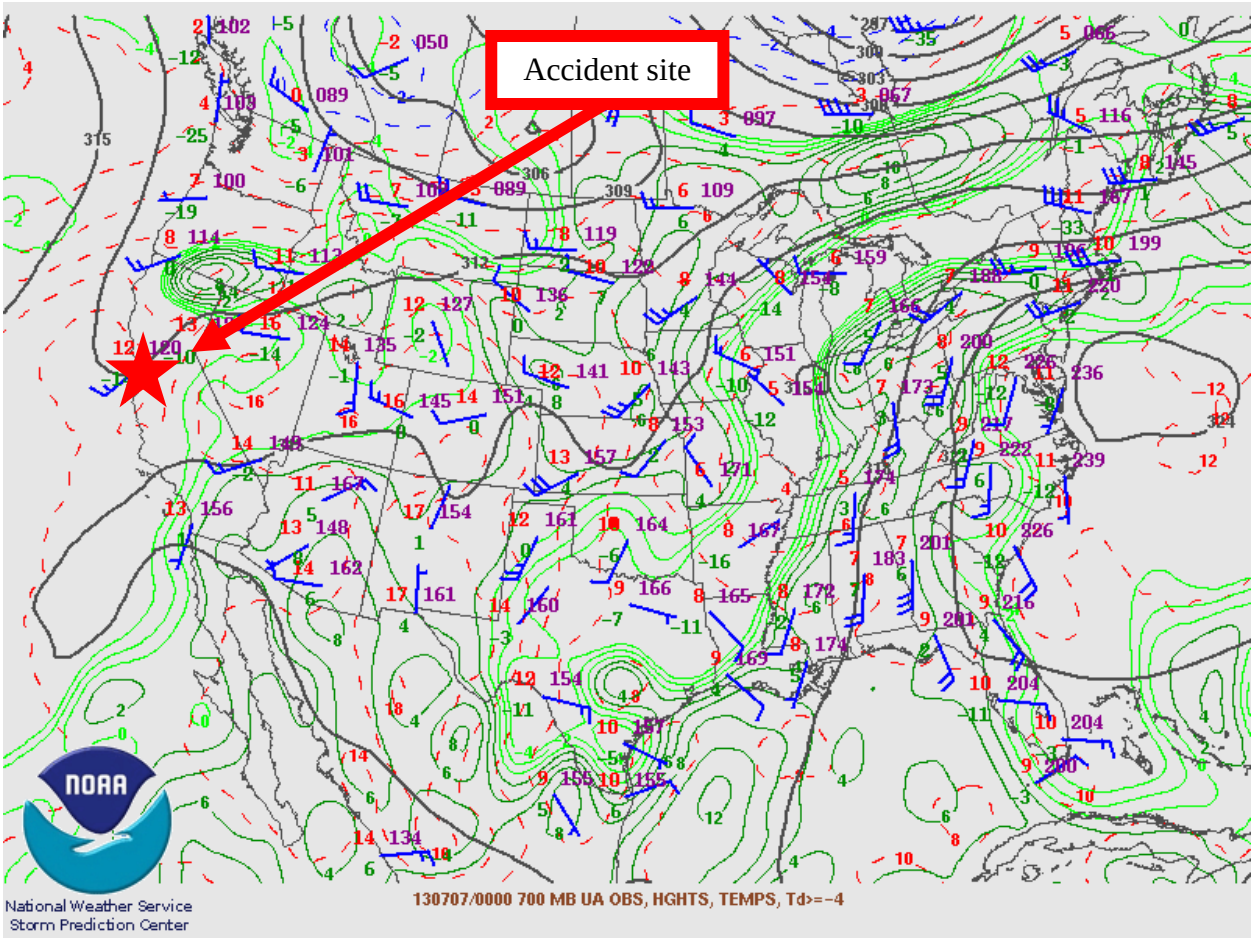


Figure 4 – 700-hPa Constant Pressure Chart for 1700 PDT

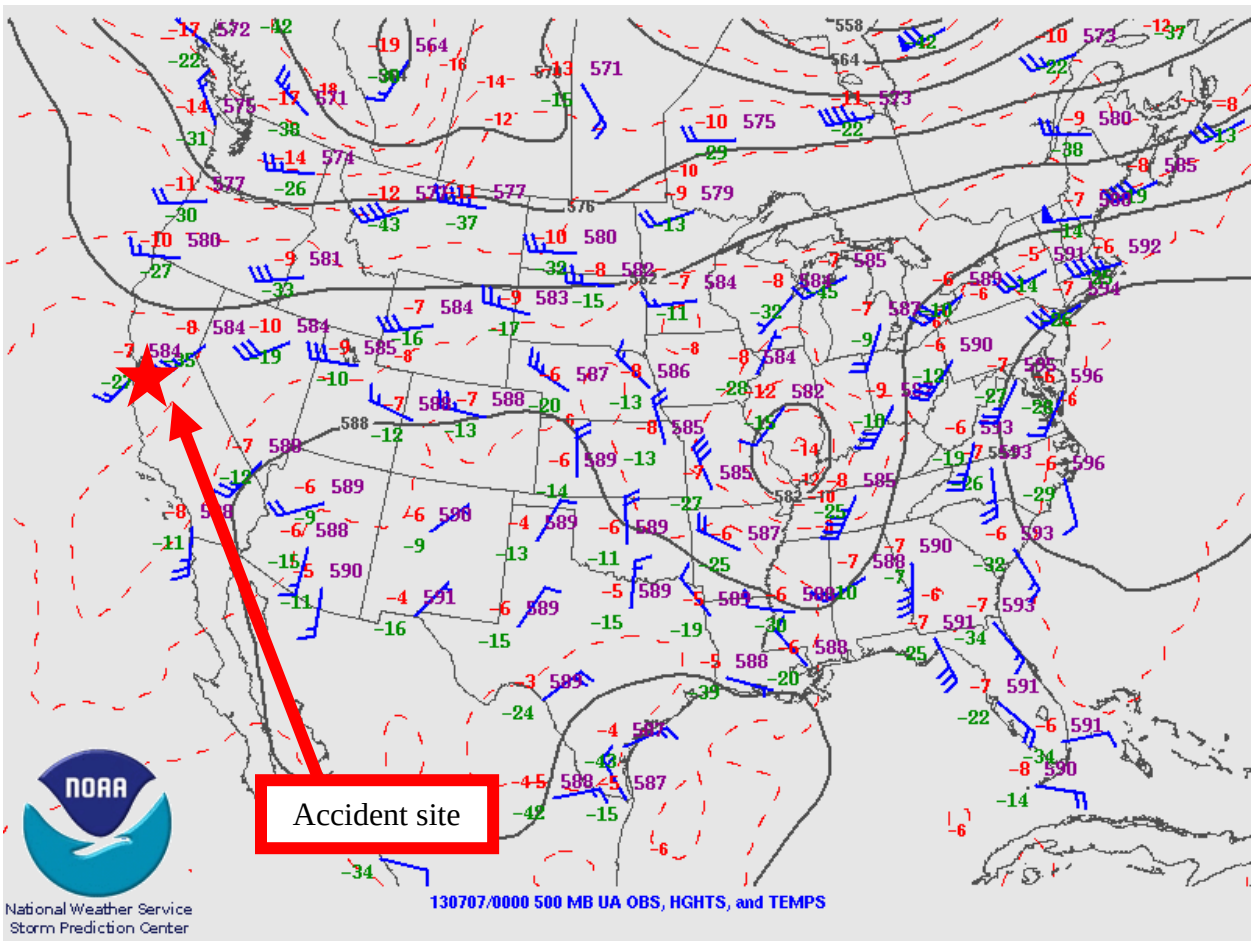


Figure 5 – 500-hPa Constant Pressure Chart for 1700 PDT

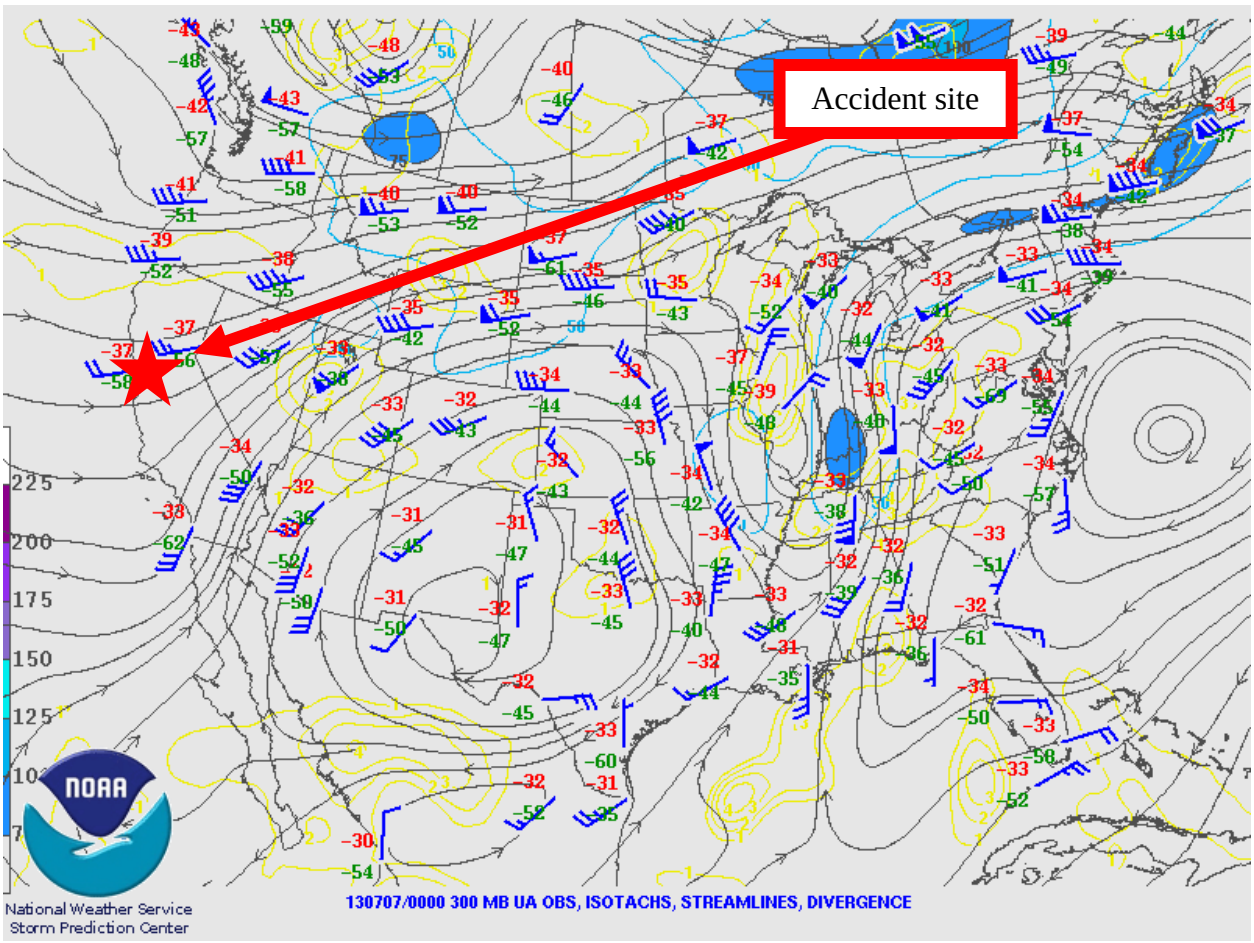


Figure 6 – 300-hPa Constant Pressure Chart for 1700 PDT

2.0 Storm Prediction Center Products

No thunderstorms or severe storms were forecast.

3.0 Surface Observations

The area surrounding the accident site was documented utilizing official NWS Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language.

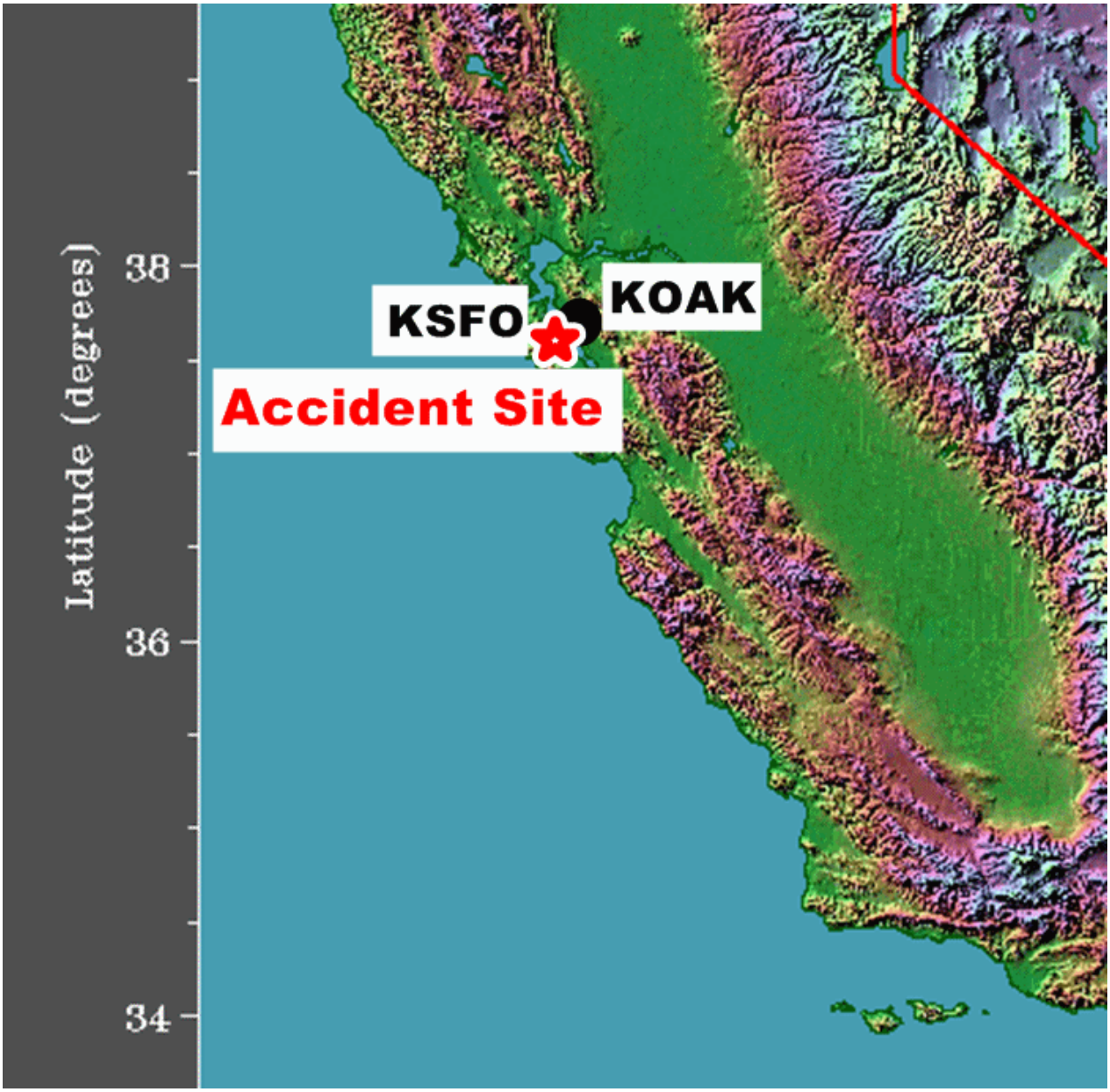


Figure 7 – Map of central California with the location of the accident site, surface observation site, and upper air sounding location

San Francisco International Airport (KSFO) located 8 miles southeast of San Francisco, California, had an Automated Surface Observing System (ASOS[3]) whose reports were supplemented by a human observer (figure 7). KSFO was located at an elevation of 13 feet and had a 17° easterly magnetic variation[4]. The following observations were taken and disseminated during the times surrounding the accident[5]:

[0556 PDT] KSFO 061256Z 00000KT 10SM FEW010 SCT013 13/09 A2980 RMK AO2 SLP089 T01280094=

[0656 PDT] KSFO 061356Z 19006KT 10SM FEW010 SCT013 13/10 A2980 RMK AO2 SLP091 T01330100=

[0756 PDT] KSFO 061456Z VRB03KT 10SM FEW010 SCT015 14/10 A2980 RMK AO2 SLP092 T01440100 51006=

[0856 PDT] KSFO 061556Z 02003KT 10SM FEW012 SCT018 16/11 A2982 RMK AO2 SLP096 T01610106=

[0956 PDT] KSFO 061656Z VRB06KT 10SM FEW013 SCT018 17/10 A2982 RMK AO2 SLP096 T01670100=

[1056 PDT] KSFO 061756Z 21006KT 10SM FEW016 18/10 A2982 RMK AO2 SLP097 T01780100 10183 20128 51005=

ACCIDENT TIME 1128 PDT

[1156 PDT] KSFO 061856Z 21007KT 170V240 10SM FEW016 18/10 A2982 RMK AO2 SLP098 T01830100=

[1256 PDT] KSFO 061956Z 23004KT 10SM FEW016 19/10 A2981 RMK AO2 SLP095 T01890100

[1356 PDT] KSFO 062056Z 08005KT 10SM FEW016 21/11 A2980 RMK AO2 SLP090 T02060106 58007=

[1456 PDT] KSFO 062156Z VRB06KT 10SM FEW016 22/11 A2978 RMK AO2 SLP085 T02170106

[1556 PDT] KSFO 062256Z 25011KT 10SM FEW013 21/10 A2978 RMK AO2 SLP085 T02060100

[3] ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.
[4] Magnetic variation – The angle (at a particular location) between magnetic north and true north.
[5] The bold sections in this NWS product and the rest of products in the weather factual report are to highlight the individual sections that directly reference the weather conditions that are or will affect the accident location around the accident time.

[1656 PDT] KSFO 062356Z 23015KT 10SM FEW012 20/10 A2977 RMK AO2 SLP082 T02000100 10222 20178 56008

KSFO weather at 0956 PDT, wind variable at 6 knots, 10 miles visibility, few clouds at 1,300 feet above ground level (agl), scattered clouds at 1,800 feet agl, temperature of 17° Celsius (C), dew point temperature of 10° C, and an altimeter setting of 29.82 inches of mercury. Remarks: automated station with precipitation discriminator, sea level pressure 1009.6 hPa, temperature of 16.7° C, dew point temperature of 10.0° C.

KSFO weather at 1056 PDT, wind from 210° at 6 knots, 10 miles visibility, few clouds at 1,600 feet agl, temperature of 18° C, dew point temperature of 10° C, and an altimeter setting of 29.82 inches of mercury. Remarks: automated station with precipitation discriminator, sea level pressure 1009.7 hPa, temperature of 17.8° C, dew point temperature of 10.0° C, 6-hourly maximum temperature of 18.3° C, 6-hourly minimum temperature of 12.8° C, 3-hourly pressure increase of 0.5 hPa.

KSFO weather at 1156 PDT, wind from 210° at 7 knots, wind variable between 170° and 240°, 10 miles visibility, few clouds at 1,600 feet agl, temperature of 18° C, dew point temperature of 10° C, and an altimeter setting of 29.82 inches of mercury. Remarks: automated station with precipitation discriminator, sea level pressure 1009.8 hPa, temperature of 18.3° C, dew point temperature of 10.0° C.

KSFO weather at 1256 PDT, wind from 230° at 4 knots, 10 miles visibility, few clouds at 1,600 feet agl, temperature of 19° C, dew point temperature of 10° C, and an altimeter setting of 29.81 inches of mercury. Remarks: automated station with precipitation discriminator, sea level pressure 1009.5 hPa, temperature of 18.9° C, dew point temperature of 10.0° C.

3.1 One Minute Wind Observations

The one-minute KSFO ASOS surface data was provided by the NWS for the time surrounding the accident. One-minute raw wind data was provided with two separate magnitudes and wind directions[6]. The first wind data in table 1 is the two-minute average wind speed, which was updated every 5 seconds and reported once a minute. The second source of one-minute wind data is the five-second maximum wind average, which was updated every five seconds and reported once every minute (table 1). The following table provides the meteorological data in local time (PST)[7] as well as UTC time.

[6] The wind directions are in reference to true north.
[7] The one-minute wind observations from an ASOS are not automatically reported in daylight time.

Time (UTC)	Time (PST)	Dir of 2min avg wind	Speed of 2 min avg wind (knots)	Dir of max 5 sec avg wind	Speed of max 5 sec avg wind (knots)
1810	1010	182	6	191	8
1811	1011	172	5	172	6
1812	1012	174	5	182	8
1813	1013	185	6	167	9
1814	1014	183	6	177	9
1815	1015	179	7	177	10
1816	1016	179	7	187	9
1817	1017	179	7	177	9
1818	1018	179	8	187	11
1819	1019	192	8	197	11
1820	1020	194	8	188	10
1821	1021	186	6	175	8
1822	1022	178	5	160	8
1823	1023	178	6	195	12
1824	1024	211	7	239	9
1825	1025	237	5	224	6
1826	1026	214	4	203	7
1827	**1027**	**182**	**5**	**153**	**8**
1828	**1028**	**171**	**4**	**175**	**5**
1829	**1029**	**180**	**4**	**172**	**6**
1830	1030	185	4	184	5
1831	1031	172	3	160	6
1832	1032	172	4	205	10
1833	1033	202	6	212	9
1834	1034	215	6	228	10
1835	1035	198	6	191	8
1836	1036	190	5	158	6
1837	1037	205	4	229	5
1838	1038	236	4	274	6
1839	1039	255	4	282	5
1840	1040	233	5	197	8
1841	1041	182	4	138	5
1842	1042	174	5	209	8
1843	1043	183	6	188	7

Table 1 – One-minute KSFO ASOS data for the time surrounding the accident

At 1127 PDT, KSFO reported the two-minute average wind from 182° at 5 knots and a five-second maximum average wind from 153° at 8 knots.

At 1128 PDT, KSFO reported the two-minute average wind from 171° at 4 knots and a five-second maximum average wind from 175° at 5 knots.

At 1129 PDT, KSFO reported the two-minute average wind from 180° at 4 knots and a five-second maximum average wind from 172° at 6 knots.

4.0 Upper Air Data

The closest official upper air sounding to the accident site was from Oakland, California (KOAK), which was approximately 10 miles northeast of the accident site, with a site number 72493, and a station elevation of 10 feet (figure 7). The 0500 PDT sounding from KOAK was plotted on a standard Skew-T log P diagram[8] with the derived stability parameters included in figure 8 (with data from the surface to 660-hPa, or 12,000 feet msl). This data was analyzed utilizing the RAOB[9] software package. The sounding depicted a relatively moist vertical environment with the Lifted Condensation Level (LCL)[10] at 1,134 feet msl, a Convective Condensation Level (CCL)[11] of 1,608 feet, and a Level of Free Convection (LFC)[12] at 1,657 feet. The freezing level was located at 16,063 feet msl. The precipitable water value was 1.01 inches.

[8] Skew T log P diagram – is a standard meteorological plot using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

[9] RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamopras, Pennsylvania.

[10] Lifting Condensation Level (LCL) - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

[11] Convective Condensation Level (CCL) – The level in the atmosphere to which an air parcel, if heated from below, will rise dry adiabatically, without becoming colder than its environment just before the parcel becomes saturated.

[12] Level of Free Convection (LFC) – The level at which a parcel of saturated air becomes warmer than the surrounding air and begins to rise freely. This occurs most readily in a conditionally unstable atmosphere.

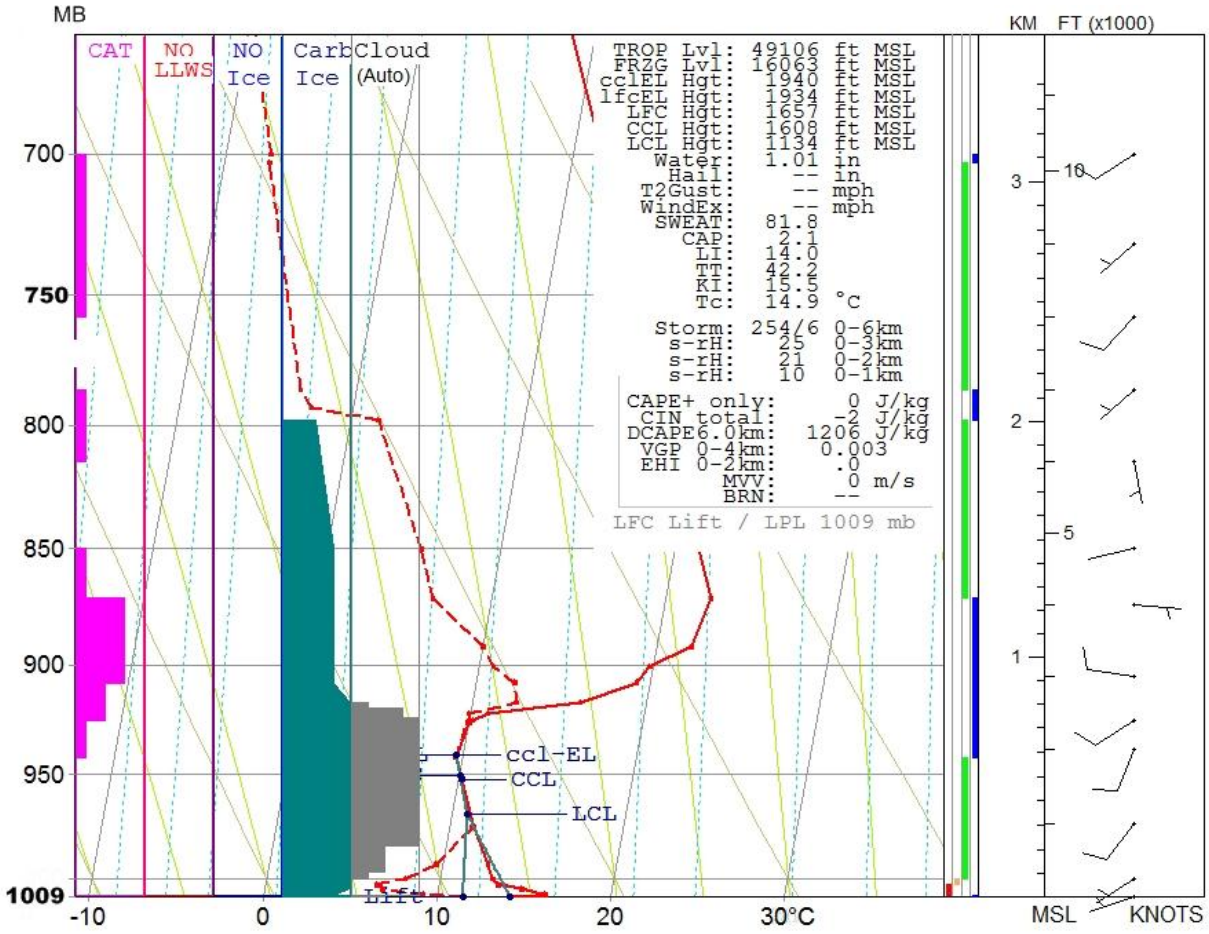


Figure 8 – 0500 PDT KOAK sounding

The 0500 PDT KOAK sounding indicated a conditionally unstable vertical environment from the surface through 2,000 feet msl with an area of increased moisture between 1,500 and 2,500 feet msl. Above 2,000 feet the sounding became more stable with a few layers of conditionally instability through 12,000 feet and the sounding from 2,500 through 12,000 feet remained relatively dry. This environment would have been conducive of cloud formation as indicated by RAOB, especially from 1,500 feet through 2,500 feet. No icing was indicated by RAOB.

The sounding wind profile indicated there was a surface wind from 250° at 6 knots and the wind remained at 10 knots or less through 12,000 feet msl with the wind direction mostly out of the west to southwest. Low-level wind shear (LLWS) was not indicated by RAOB. Several layers of possible clear-air turbulence were identified by RAOB from 2,000 feet msl through 10,000 feet.

5.0 Satellite Data

Visible data from the Geostationary Operational Environmental Satellite number 15 (GOES-15) data was obtained from the NCDC and processed with the NTSB's Man-computer Interactive Data Access System (McIDAS) workstation. The visible imagery (GOES-15, band 1), at a wavelength of 0.65 microns (μm) was retrieved for the scene. Satellite imagery surrounding the time of the accident, from 1600 PDT through 1900 PDT at approximately 15-minute intervals, were reviewed and the closest images to the time of the accident are documented here.

Figures 9 and 10 present the GOES-15 visible imagery from 1100 and 1130 PDT at 3X magnification with the accident site highlighted with a red square. Inspection of the visible imagery indicated no cloud cover over the accident site at 1100 and 1130 PDT with cloud cover to the west of the accident site stretching into the eastern Pacific Ocean.

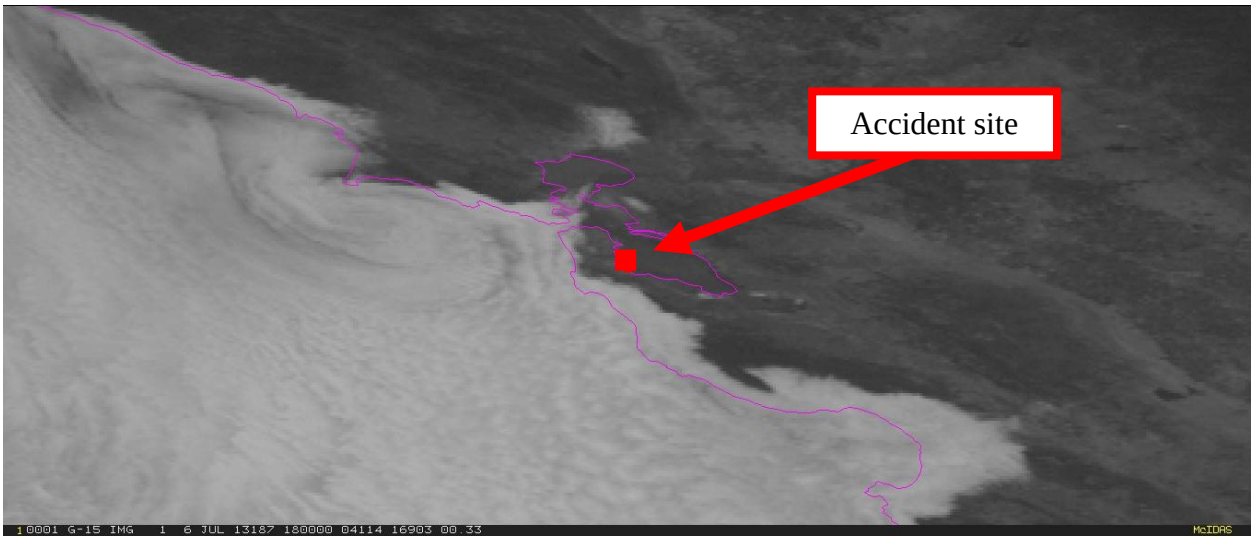


Figure 9 – GOES-15 visible image at 1100 PDT

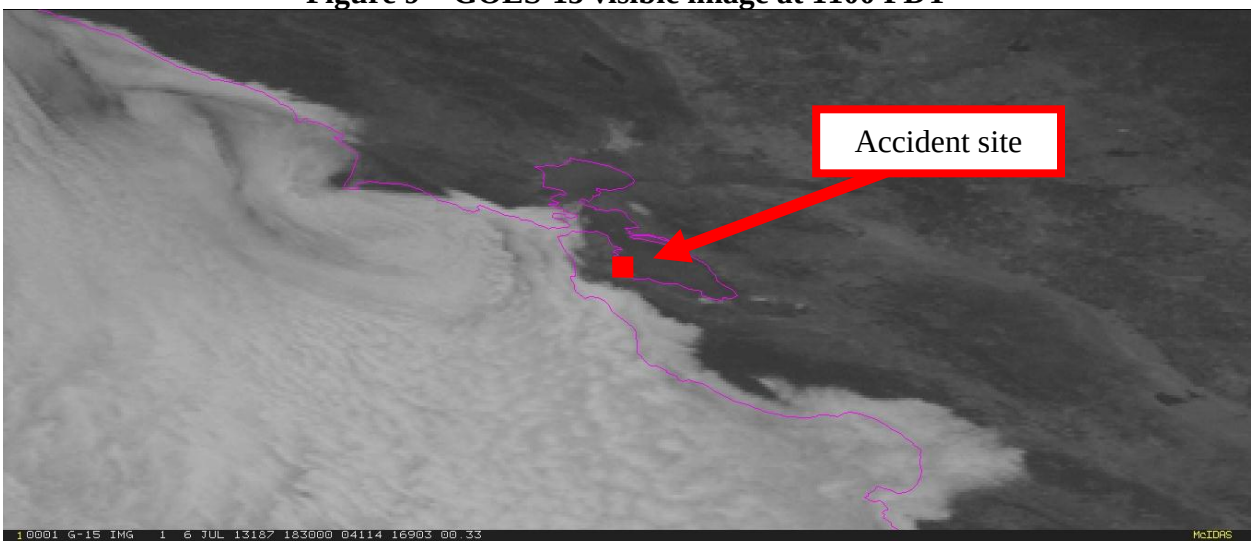


Figure 10 – GOES-15 visible image at 1130 PDT

Visible data from NASA's Terra satellite and Moderate Resolution Imaging Spectroradiometer (MODIS) was obtained from the Space Science and Engineering Center (SSEC) at the University of Wisconsin-Madison. Figure 11 presents a true color[13] MODIS image from 1150 PDT of western California with the accident location highlighted. The area of clouds is visible west of the accident site.

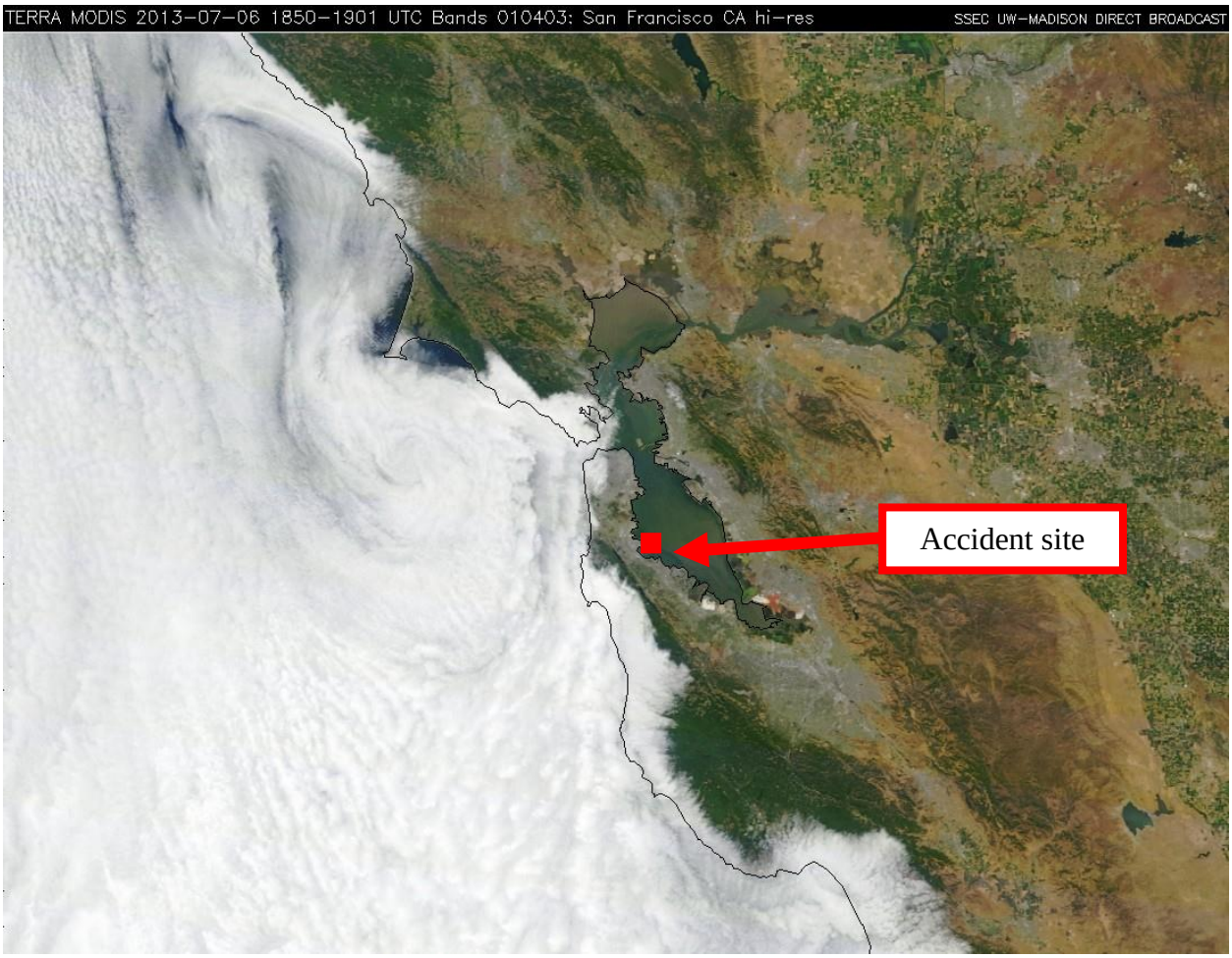


Figure 11 – MODIS true color image at 1150 PDT

6.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D) was KMUX located near San Francisco, California, approximately 35 miles southeast of the accident site at an elevation of 3,469 feet. Level II archive radar data was obtained from the NCDC utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

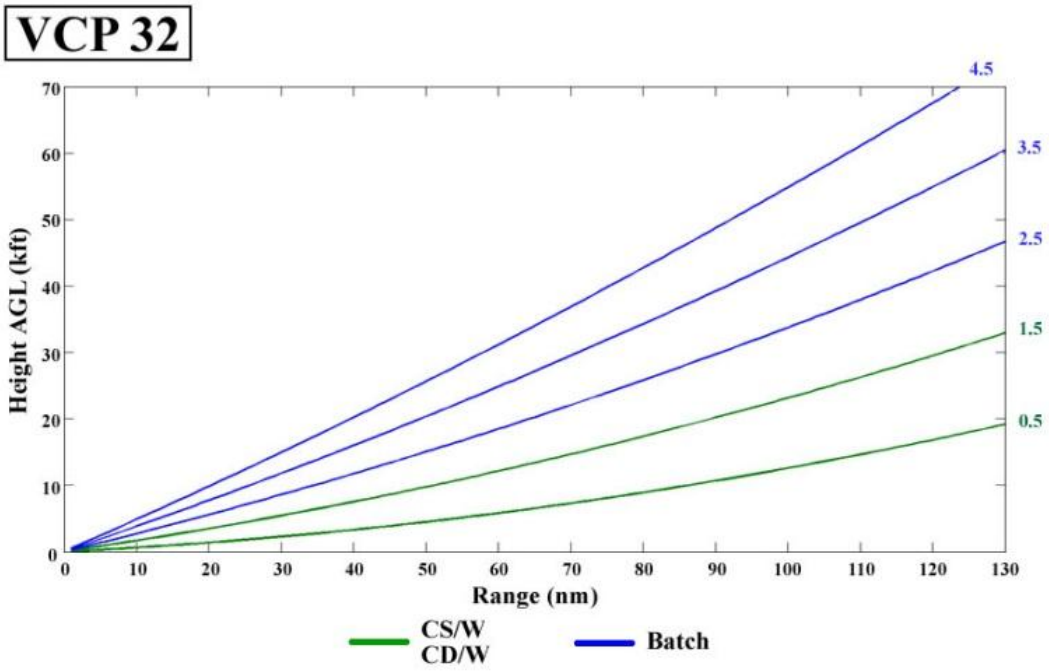
[13] True color – A true color image covers the full visible spectrum using the red, green, and blue spectral bands.

The WSR-88D is an S-band 10-centimeter wavelength radar with a power output of 750,000 watts, and with a 28-foot parabolic antenna that concentrates the energy between a 0.87° and 0.96° beam width[14]. The radar produces three basic types of products: base reflectivity, base radial velocity, and base spectral width.

6.1 Volume Scan Strategy

The WSR-88D is a computer-controlled radar system, which automatically creates a complete series of specific scans in a specific sequence known as a volume scan. Individual elevation scans are immediately available on the WSR-88D's Principle Users Processor (PUP). Products that require data from multiple elevation scans are not available until the end of the five to ten minute volume scan.

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has two common scanning strategies. The most common is where the radar makes 9 elevation scans from 0.5° to 19.5° every six minutes. This particular scanning strategy is documented as volume coverage pattern 21 (VCP-21). Mode B is the clear-air mode, where the radar makes 5 elevation scans during a ten minute period. During the period surrounding the accident, the KMUX WSR-88D radar was operating in the clear-air mode (Mode B, VCP-32). The following chart provides an indication of the different elevation angles in this VCP, and the approximate height and width of the radar beam with distance from the radar site.



VCP-32 Precipitation Mode Scan Strategy

[14] Beam width – A measure of the angular width of a radar beam.

6.2 Beam Height Calculation

Assuming standard refraction[15] of the WSR-88D 0.95° wide radar beam, the following table shows the approximate beam height and width information[16] of the radar display over the site of the accident. The heights have been rounded to the nearest 10 feet.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP	BEAM WIDTH
0.5°	6,210 feet	4,480 feet	7,940 feet	3,460 feet

Based on the radar height calculations, the 0.5° elevation scan depicted the conditions between 4,480 feet and 7,940 feet msl over the accident site.

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[17] it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in decibels (dBZ[18]), and is a general measure of echo intensity. The chart below relates the NWS video integrator and processor (VIP) intensity levels versus the WSR-88D's display levels, precipitation mode reflectivity in decibels, and rainfall rates.

[15] Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

[16] Beamwidth values are shown for legacy resolution products. Super resolution products would an effective beamwidth that would be approximately half these values.

[17] Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth's surface; also, any water particles blown by the wind from the earth's surface. Hydrometeors are classified as; (a) Liquid or solid water particles suspended in the air: cloud, water droplets, mist or fog. (b) Liquid precipitation: drizzle and rain. (c) Freezing precipitation: freezing drizzle and freezing rain. (d) Solid (frozen) precipitation: ice pellets, hail, snow, snow pellets, and ice crystals. (e) Falling particles that evaporate before reaching the ground: virga. (f) Liquid or solid water particles lifted by the wind from the earth's surface: drifting snow, blowing snow, blowing spray. (g) Liquid or solid deposits on exposed objects: dew, frost, rime, and glazed ice.

[18] dBZ – A non-dimensional "unit" of radar reflectivity which represents a logarithmic power ratio (in decibels , or dB) with respect to radar reflectivity factor, Z.

NWS VIP/DBZ CONVERSION TABLE

NWS VIP	WSR-88D LEVEL	PREC MODE DBZ	RAINFALL
0	0	< 5	
	1	5 to 9	
	2	10 to 14	
1	3	15 to 19	.01 in/hr
Very Light	4	20 to 24	.02 in/hr
	5	25 to 29	.04 in/hr
2	6	30 to 34	.09 in/hr
Light to	7	35 to 39	.21 in/hr
Moderate			
3	8	40 to 44	.48 in/hr
Strong			
4	9	45 to 49	1.10 in/hr
Very Strong			
5	10	50 to 54	2.49 in/hr
Intense			
6	11	55 to 59	>5.67 in/hr
Extreme	12	60 to 64	
	13	65 to 69	
	14	70 to 74	
	15	> 75	

The Federal Aviation Administration (FAA) Advisory Circular AC 00-24B titled "Thunderstorms" dated January 2, 1983, also defines the echo intensity levels and potential weather phenomena associated with those levels. If the maximum VIP Level is 1 "weak" and 2 "moderate", then light to moderate turbulence is possible with lightning. VIP Level 3 is "strong" and severe turbulence is possible with lightning. VIP Level 4 is "very heavy" and severe turbulence is likely with lightning. VIP Level 5 is "intense" with severe turbulence, lightning, hail likely, and organized surface wind gusts. VIP Level 6 is "extreme" with severe turbulence, lightning, large hail, extensive surface wind gusts and turbulence.

6.4 Base Reflectivity and Lightning Data

Figure 12 presents the KMUX WSR-88D base reflectivity image for the 0.5° elevation scan initiated at 1115 PDT with a resolution of 0.5° X 250 m. There were no reflectivity targets above or near the accident site at the accident time. There were no lightning strikes near the accident site at the accident time.

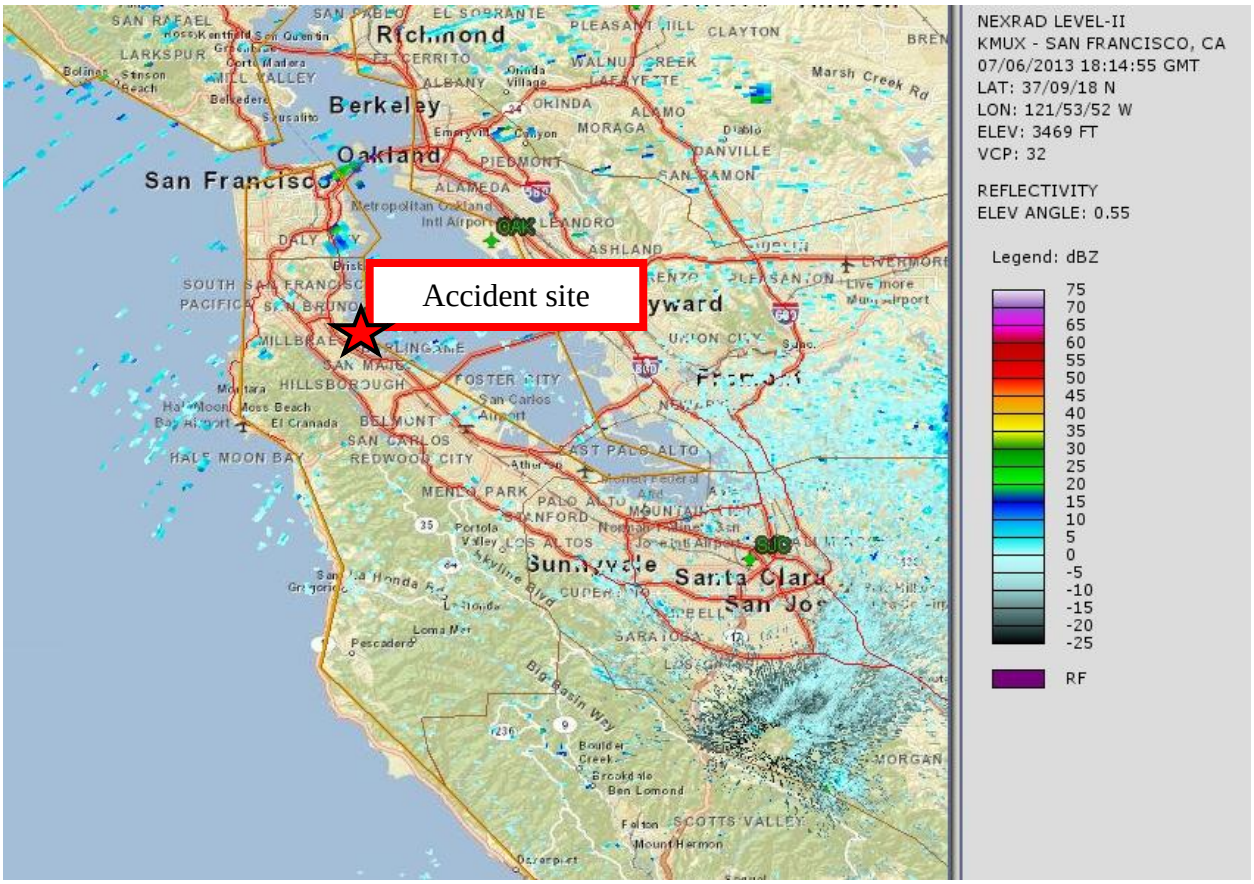
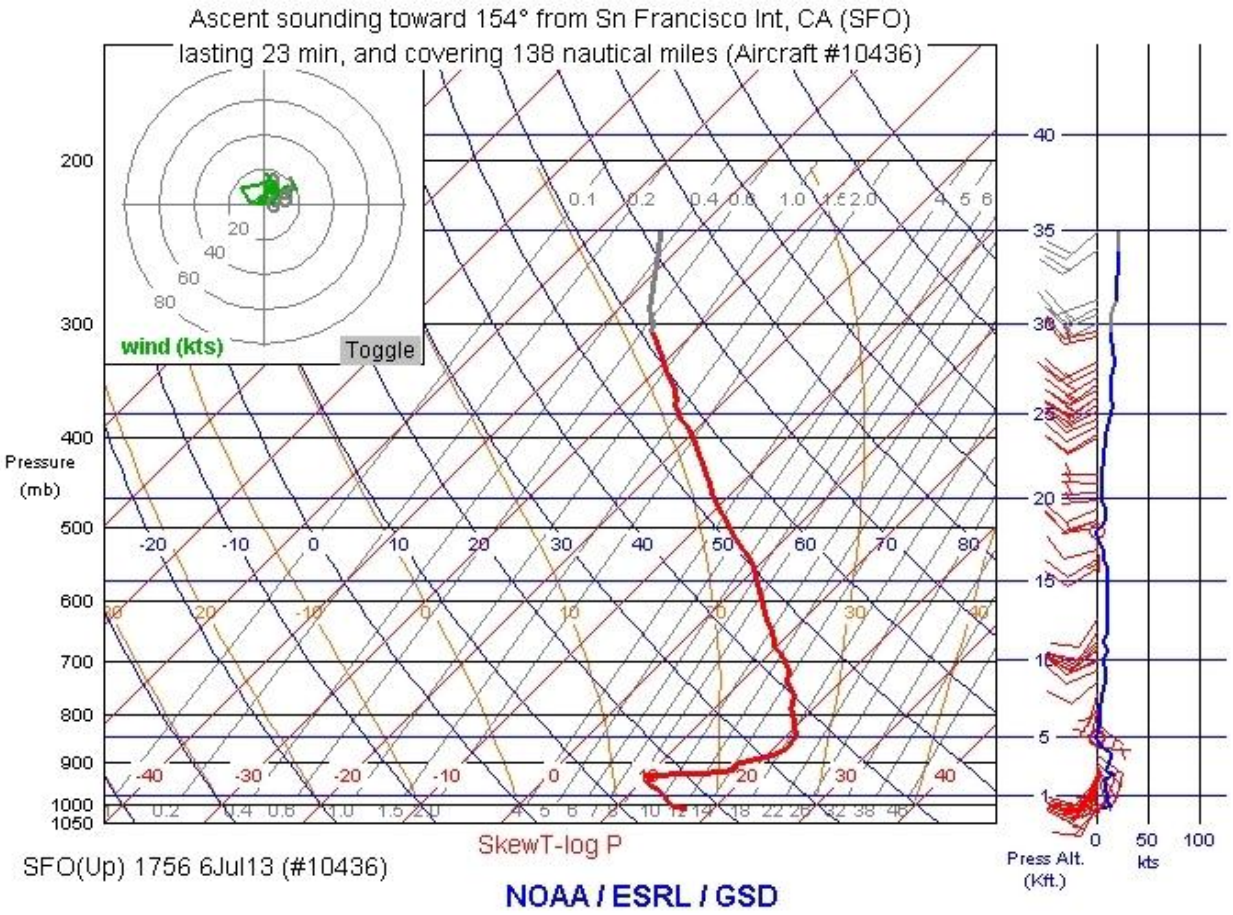


Figure 12 – KMUX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1115 PDT

7.0 AMDAR Data

An aircraft that provided Aircraft Meteorological Data Reports (AMDAR) identified as aircraft #10436[19] departed KSFO at 1056 PDT (1756Z) approximately 32 minutes prior to the accident time and retrieved meteorological data on its departure (table 2):

[19] Aircraft #10436 – The aircraft number was determined by the AMDAR data display from the Earth System Research Laboratory's Global Systems Division (ESRL/GSD).



P_alt[20] (ft)	hPa	t/td[21] (°C)	w_dir/w_spd[22] (kts)	Time (UTC)	Bng/Rng[23] (nm)
120	**1009**	**17.1/-----**	**220°/007**	**1756**	**84°/001**
230	**1005**	**15.7/-----**	**208°/015**	**1756**	**41°/001**
560	**993**	**14.7/-----**	**227°/012**	**1756**	**58°/001**
970	978	13.7/-----	224°/011	1756	40°/002
1330	965	12.6/-----	219°/010	1756	40°/002
1470	961	12.1/-----	222°/010	1756	40°/002

Table 2 – AMDAR meteorological data on a flight departing KSFO 32 minutes prior to the accident time

At 1056 PDT and with a pressure altitude of 120 feet, the pressure was 1009 hPa, the air temperature was 17.1° C, and the wind was from 220° at 7 knots.

[20] P_alt – Pressure altitude is the indicated altitude when an altimeter is set to an agreed baseline pressure setting. The baseline pressure setting is 1013.25 hPa or 29.92 inches of mercury

[21] t/td – Air temperature and dew point temperature in degrees Celsius.

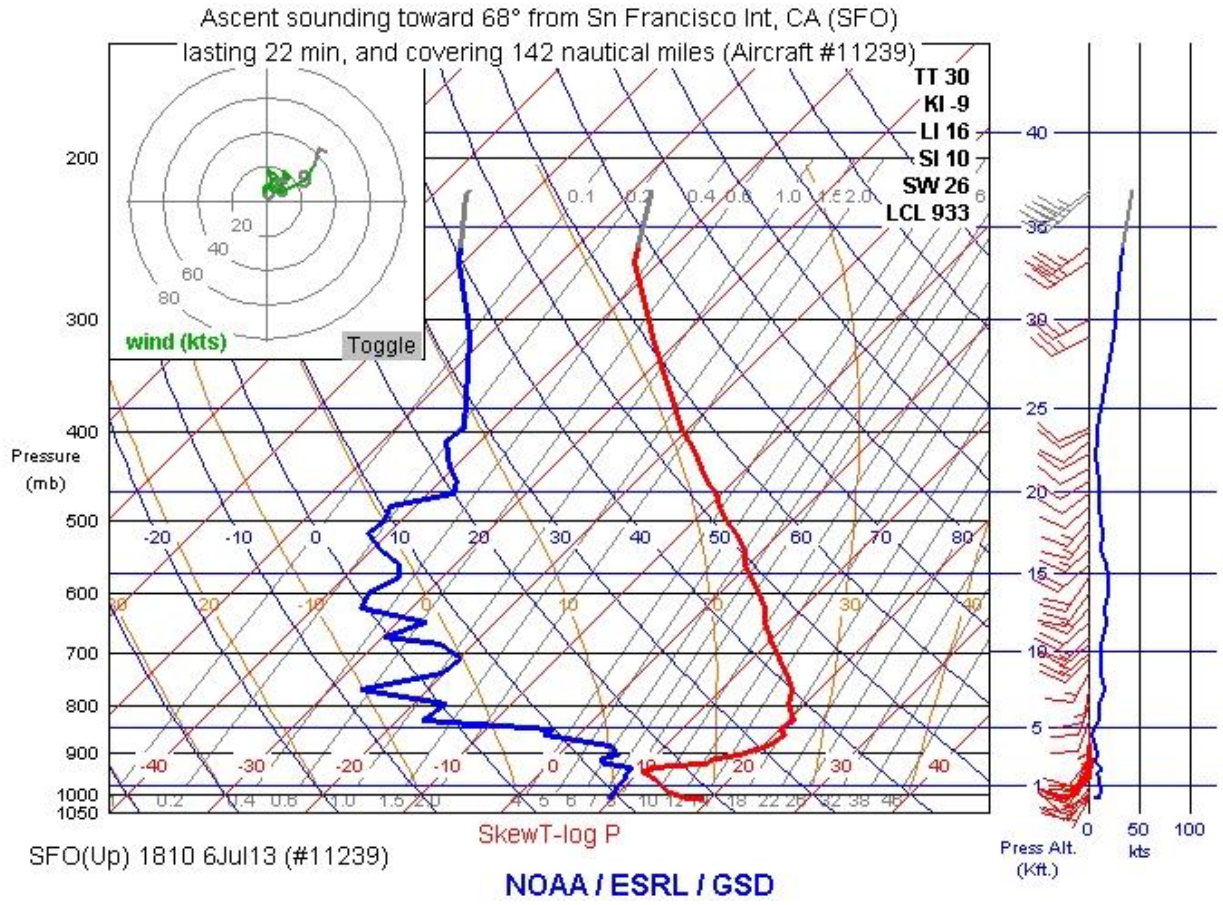
[22] w_dir/w_spd – Wind direction (reference to true north) and wind speed in knots.

[23] Bng/Rng – The angle and distance from the start point. In this case the start point was KSFO.

At 1056 PDT and with a pressure altitude of 230 feet, the pressure was 1005 hPa, the air temperature was 15.7° C, and the wind was from 208° at 15 knots.

At 1056 PDT and with a pressure altitude of 560 feet, the pressure was 993 hPa, the air temperature was 14.7° C, and the wind was from 227° at 12 knots.

Another aircraft provided AMDAR data and was identified as aircraft #11239 departed KSFO at 1110 PDT (1810Z) approximately 18 minutes prior to the accident time and retrieved meteorological data on its departure (table 3):



P_alt (ft)	hPa	t/td (°C)	w_dir/w_spd (kts)	Time (UTC)	Bng/Rng (nm)
100	**1010**	**18.6/9.800**	**246°/010**	**1810**	**84°/001**
120	**1009**	**19.3/9.700**	**207°/006**	**1810**	**59°/000**
140	**1008**	**17.5/9.700**	**227°/011**	**1810**	**84°/001**
300	1002	16.1/9.600	240°/012	1810	41°/001
510	995	15.1/9.500	215°/013	1811	58°/001
810	984	14.1/9.400	214°/014	1811	58°/001

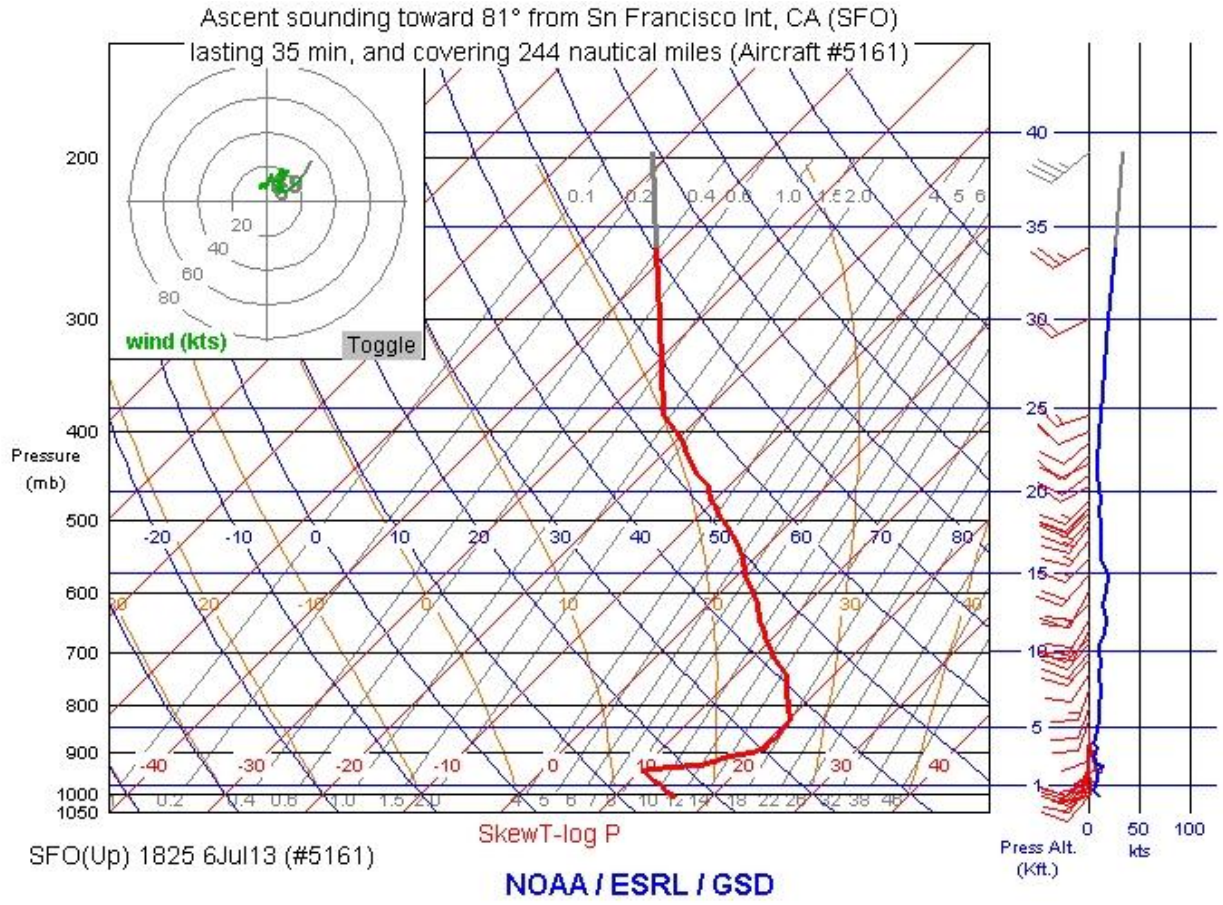
Table 3 – AMDAR meteorological data on a flight departing KSFO 18 minutes prior to the accident time

At 1110 PDT and with a pressure altitude of 100 feet, the pressure was 1010 hPa, the air temperature was 18.6° C, the dew point temperature was 9.8° C, and the wind was from 246° at 10 knots.

At 1110 PDT and with a pressure altitude of 120 feet, the pressure was 1009 hPa, the air temperature was 19.3° C, the dew point temperature was 9.7° C, and the wind was from 207° at 6 knots.

At 1110 PDT and with a pressure altitude of 140 feet, the pressure was 1008 hPa, the air temperature was 17.5° C, the dew point temperature was 9.7° C, and the wind was from 227° at 11 knots.

Another aircraft provided AMDAR data and was identified as aircraft #5161 departed KSFO at 1125 PDT (1825Z) approximately 3 minutes prior to the accident time and retrieved meteorological data on its departure (table 4):



P_alt (ft)	hPa	t/td (°C)	w_dir/w_spd (kts)	Time (UTC)	Bng/Rng (nm)
90	**1010**	**16.2/-----**	**---°/---**	**1825**	**84°/001**
240	**1004**	**16.1/-----**	**219°/012**	**1825**	**58°/001**
610	**991**	**14.6/-----**	**229°/007**	**1825**	**58°/001**
1000	977	13.6/-----	213°/008	1825	50°/002
1360	964	12.2/-----	220°/009	1825	58°/002
1690	953	11.2/-----	218°/009	1825	47°/003

Table 4 – AMDAR meteorological data on a flight departing KSFO 3 minutes prior to the accident time

At 1125 PDT and with a pressure altitude of 90 feet, the pressure was 1010 hPa, the air temperature was 16.2° C.

At 1125 PDT and with a pressure altitude of 240 feet, the pressure was 1004 hPa, the air temperature was 16.1° C, and the wind was from 219° at 12 knots.

At 1125 PDT and with a pressure altitude of 610 feet, the pressure was 991 hPa, the air temperature was 14.6° C, and the wind was from 229° at 7 knots.

8.0 LIDAR Data

Two FAA Light Detection and Ranging (LIDAR) sensors were located close to the accident site (figure 13). Wind data from these LIDARs was captured around the accident time and is listed below (tables 5 through 8):

Figure 13 – Position of FAA LIDAR sensors relative to the accident site

Height (ft)[24]	Wind Speed (kts)	Wind Direction (°)[25]
200.9	**8.38**	**200.73**
263.7	**6.93**	**208.32**
326.4	**6.53**	**215.51**
389.2	7.35	211.82
452.0	6.26	220.84
514.8	6.34	222.23

Table 5 – LIDAR data from 1113 PDT from FAA LIDAR sensor 3

At 1113 PDT and 211.9 above local ground[26] the wind was from 200.73° at 8.38 knots.

At 1113 PDT and 274.7 above local ground the wind was from 208.32° at 6.93 knots.

At 1113 PDT and 337.4 above local ground the wind was from 215.51° at 6.53 knots.

Height (ft)	Wind Speed (kts)	Wind Direction (°)
200.9	**7.42**	**195.72**
263.7	**7.98**	**198.58**
326.4	**8.21**	**187.27**
389.2	8.92	191.40
452.0	6.24	199.00
514.8	7.44	201.74

Table 6 – LIDAR data from 1133 PDT from FAA LIDAR sensor 3

At 1133 PDT and 211.9 above local ground the wind was from 195.72° at 7.42 knots.

At 1133 PDT and 274.7 above local ground the wind was from 198.58° at 7.98 knots.

At 1133 PDT and 337.4 above local ground the wind was from 187.27° at 8.21 knots.

[24] Height – Height in Feet, With Respect to the Scanner (11 ft Above the Local Ground) – so The First Altitude is 200.9 Feet Above the Scanner, Which is 11 ft Above Local Ground).
[25] Wind direction in reference to true north.
[26] Local Ground is approximately 13 feet above sea level.

Height (ft)	Wind Speed (kts)	Wind Direction (°)
200.9	**4.11**	**193.11**
263.7	**6.33**	**180.72**
326.4	**8.68**	**190.93**
389.2	8.96	197.06
452.0	7.72	210.18
514.8	10.19	203.89

Table 7 – LIDAR data from 1112 PDT from FAA LIDAR sensor 4

At 1112 PDT and 211.9 above local ground the wind was from 193.11° at 4.11 knots.

At 1112 PDT and 274.7 above local ground the wind was from 180.72° at 6.33 knots.

At 1112 PDT and 337.4 above local ground the wind was from 190.93° at 8.68 knots.

Height (ft)	Wind Speed (kts)	Wind Direction (°)
200.9	**7.16**	**205.15**
263.7	**6.06**	**207.76**
326.4	**8.33**	**202.22**
389.2	6.68	185.80
452.0	9.56	202.80
514.8	10.42	194.90

Table 8 – LIDAR data from 1132 PDT from FAA LIDAR sensor 4

At 1132 PDT and 211.9 above local ground the wind was from 205.15° at 7.16 knots.

At 1132 PDT and 274.7 above local ground the wind was from 207.76° at 6.06 knots.

At 1132 PDT and 337.4 above local ground the wind was from 202.22° at 8.33 knots.

9.0 Pilot Reports

Pilot reports (PIREPs) were reviewed close to the accident site from around two hours prior to the accident time to around two hours after the accident time and this PIREP was disseminated near the accident aircraft's flight altitude:

MRY UA /OV MRY /TM 1926 /FLUNKN /TP CRJ2 /SK BKN014-TOP021 /RM
DURC DEP RWY 28L=

Routine pilot report (UA); Over Monterey, California; Time – 1226 PDT (1926Z); Altitude – unknown; Type aircraft – Bombardier CRJ200; Sky – Broken at 1,400 feet with tops at 2,100 feet agl; Remarks – During climb departing runway 28L.

10.0 SIGMET and CWSU Advisory

No SIGMET was valid for the accident site at the accident time.

No CWSU Advisory (CWA) was valid for the accident site at the accident time.

No Meteorological Impact Statement (MIS) was valid for the accident site at the accident time.

11.0 AIRMETs

AIRMET Sierra was valid for the accident site at the accident time. It was issued at 0745 PDT and forecasted IFR[27] conditions with ceilings below 1,000 feet and visibility below 3 miles in mist:

WAUS46 KKCI 061445
WA6S
_SFOS WA 061445
AIRMET SIERRA UPDT 2 FOR IFR AND MTN OBSCN VALID UNTIL 062100
.
AIRMET IFR...OR CA AND CSTL WTRS
FROM 60WSW OED TO 20SW ENI TO 40SW MOD TO 30NW RZS TO 40ENE LAX
TO 30E MZB TO 220SW MZB TO 130WSW ENI TO 60WSW OED
CIG BLW 010/VIS BLW 3SM BR. CONDS CONTG BYD 21Z THRU 03Z.
.

12.0 Terminal Aerodrome Forecast

KSFO had a NWS TAF. The TAF valid at the time of the accident was issued at 1058 PDT and was valid for a 30-hour period beginning at 1100 PDT. The TAF forecast for KSFO was as follows:

TAF AMD KSFO 061758Z **0618/0724 VRB04KT P6SM FEW012**
FM061900 29012KT P6SM FEW012
FM070700 26005KT P6SM BKN007
FM071600 23004KT P6SM FEW010
FM072000 29012KT P6SM FEW015=

The forecast expected variable wind at 4 knots, visibility greater than 6 miles, and few clouds at 1,200 feet agl.

[27] Instrument Flight Rules – Refers to the general weather conditions pilots can expect at the surface. IFR criteria means a ceiling below 1,000 feet agl and/or less than 3 miles visibility.

13.0 Area Forecast

The Area Forecast issued at 0345 PDT forecasted a broken ceiling at 1,500 feet msl with the cloud tops at 2,500 feet msl. The skies were forecast to clear between 1200 and 1400 PDT with occasional scattered clouds at 1,500 feet:

FAUS46 KKCI 061045
FA6W
_SFOC FA 061045
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 070500
CLDS/WX VALID UNTIL 062300...OTLK VALID 062300-070500
WA OR CA AND CSTL WTRS
.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.
.
SYNOPSIS...ALF...TROF WRN WA TO NRN CA CSTL WTRS. HI PRES OVR
RMNDR OF FA RGN. LTL CHG THRU PD. SFC...CDFNT SERN MT-SERN
ID-SERN OR. TROF ERN WA. TROF ERN CO T0 SERN NM. HI PRES ELSW.
00Z CDFNT SERN WY-NWRN WY-SERN ID-SERN OR-NERN CA. TROF ERN NM.
HI PRES ELSW. 05Z QSTNRY FNT E CNTRL WY-SERN ID-SERN OR. TROF ERN
NM.
.
WA CASCDS WWD
CSTL SXNS...OVC015 TOP 030. BECMG 2123 SCT010-025. OTLK...VFR.
CASCDS...
WRN SLPS...BKN040 TOP 060. 18Z SCT060. OTLK...VFR.
RMNDR CASCDS...SKC. OTLK...VFR.
RMNDR...SCT015. BECMG 1921 SKC. OTLK...VFR.
.
WA E OF CASCDS
NERN MTNS...SCT130-150. 21Z SKC. OTLK...VFR.
RMNDR...SKC. OTLK...VFR.
.
OR CASCDS WWD
CSTL SXNS...BKN025 TOP 030. 18Z SCT025. OTLK...VFR.
WILLAMETTE VLY...SKC OCNL SCT040. 18Z SCT050. OTLK...VFR.
SWRN INTR...SKC. OTLK...VFR.
CASCDS...SKC. OTLK...VFR.
.
OR E OF CASCDS
SKC. OTLK...VFR.
.
NRN CA...STS-SAC-TVL LN NWD
CSTL SXNS...
FOT NWD...BKN010 TOP 025. 19Z SCT015. OTLK...VFR 04Z MVFR CIG.
S FOT...SKC. OTLK...VFR.
RMNDR...SKC. OTLK...VFR.
.
CNTRL CA
CSTL SXNS...
SNS NWD...BKN015 TOP 025. BECMG 1921 SKC OCNL SCT015. OTLK...VFR.
INVOF RZS...BKN010 TOP 020. 18Z SKC. OTLK...VFR.

RMNDR CSTL SXNS...SKC. OTLK...VFR.
SAN JOAQUIN VLY...SKC. OTLK...VFR.
SRN SIERNEV...SKC OCNL SCT CI SRN PTN. OTLK...VFR.
.
SRN CA..VBG-NID-60NNW BIH LN SWD
CSTL SXNS...
LAX NWD...OVC010 TOP 020. 22Z SCT015. OTLK...VFR 02Z IFR CIG.
S LAX...BKN-OVC015 TOP 020. BECMG 1921 SKC. OTLK...VFR 00Z MVFR
CIG.
MOJAVE-INTR MTNS...SKC OCNL SCT CI. OTLK...VFR.
RMNDR...SKC. 21Z BKN150 TOP FL180. ISOL -SHRA/TSRA. CB TOP FL450.
OTLK...VFR TIL 02Z SHRA TSRA.
.
CSTL WTRS
WA/OR...BKN-OVC020 TOP 040. OTLK...MVFR CIG.
CA...
NRN...SCT015. WND NW G40KT. OTLK...VFR WND.
CNTRL-SRN...BKN010-015 TOP 030. OTLK...IFR CIG.
....

14.0 National Weather Service Area Forecast Discussion

The National Weather Service Office in the San Francisco Bay area, California, issued the following Area Forecast Discussion at 1102 PDT which discussed VFR[28] ceiling conditions during the day and IFR ceiling conditions returning during the overnight hours:

FXUS66 KMTR 061802
AFDMTR
AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE SAN FRANCISCO BAY AREA
1102 AM PDT SAT JUL 6 2013
.DISCUSSION...AS OF 09:00 AM PDT SATURDAY...MARINE LAYER AROUND
2200 FEET HAS KEPT LOW STRATUS OVER THE COASTAL LOCATIONS AND
VALLEYS THIS MORNING. EXPECTING SOME IMPROVEMENT OVER THE VALLEYS
AS SURFACE TEMPERATURES INCREASE LATER THIS MORNING. HOWEVER...THE
CLOUD CLOUDS WILL LIKELY REMAIN IN PLACE ALONG THE COAST AND KEEP
TEMPERATURES IN THE UPPER 50S TO LOWER 60S.
&&
.PREV DISCUSSION...AS OF 3:18 AM PDT SATURDAY...THE MARINE LAYER HAS
DEEPENED TO OVER 2400 FEET PER THE FORT ORD PROFILER...AND LATEST
SATELLITE IMAGERY SHOWS THAT THE COASTAL LOW CLOUDS HAVE FILLED
MOST INLAND VALLEYS. THE SURFACE PRESSURE GRADIENT IS
MODERATE/STRONG ONSHORE WITH 2.4 MB FROM SFO TO SAC. AIRPORT
SURFACE OBSERVATIONS ARE NOT INDICATING ANY FOG RESTRICTIONS...BUT
WHERE THE CLOUD DECK IS INTERSECTING THE HIGHER TERRAIN...THERE
WILL BE FOG. CLOUDS WILL LIKELY BE SLOW TO CLEAR TODAY GIVEN THE
THICKNESS OF THE CLOUD DECK. THUS...HIGH TEMPERATURES ARE EXPECTED
TO BE SIMILAR TO FRIDAY'S WITH HIGHS RANGING FROM THE MID 50S TO
LOWER 60S AT THE COAST...TO THE 70S TO 80S INLAND...MAYBE UP TO 90
IN THE FAR INLAND AREAS OF SAN BENITO AND SOUTHERN MONTEREY
COUNTY.

[28] Visual Flight Rules – Refers to the general weather conditions pilots can expect at the surface. VFR criteria means a ceiling greater than 3,000 feet agl and greater than 5 miles visibility.

THE UPPER LEVEL TROUGH WILL REMAIN ALONG THE COAST THROUGH THE
WEEKEND AND GRADUALLY BEGIN FILLING AS AN UPPER RIDGE EDGES
WESTWARD FROM THE DESERT SOUTHWEST. THIS WILL BRING A WARMING TREND TO
THE AREA BEGINNING ON SUNDAY AND PEAKING ON TUESDAY. THIS WARM-UP
WILL ONLY SERVE TO NUDGE TEMPERATURES A BIT ABOVE NORMAL...NO
WHERE NEAR THE LEVELS OBSERVED DURING THE PAST LONG HEATWAVE.
ANOTHER TROUGH WILL APPROACH THE COAST BY WEDNESDAY BRINGING
COOLER TEMPS THROUGH THE END OF THE WEEK.
&&
.AVIATION...AS OF 11:00 AM PDT SATURDAY...SATELLITE SHOWS THAT
CLOUDS HAVE CLEARED OUT OF MOST TERMINALS EXCEPT AROUND MONTEREY
BAY. WITH THE MARINE LAYER STEADY AROUND 2300 FEET PLUS AN ONSHORE
FLOW FORECAST TONIGHT, FEEL THAT WE WILL SEE IFR/MVFR THIS EVENING
AT ALL SPOTS. WINDS SHOULD NOT BE A FACTOR ONCE THEY SWITCH TO THE
WEST AT SJC. MODERATE TO HIGH CONFIDENCE OVERALL.
**VICINITY OF KSFO...VFR TODAY WITH IFR CIGS FORECAST TO RETURN
OVERNIGHT. SOME CONCERN THAT CIGS COULD RETURN EARLIER THAN THE
TAF. FOR NOW WILL GO WITH GUIDANCE THAT HAS IT AROUND 07Z, BUT MAY
HAVE TO AMEND FOR AN EARLIER TIME DEPENDING ON HOW THE AFTERNOON
PROGRESSES DUE TO AMOUNT OF CLOUDS JUST OFF THE COAST PLUS
MODERATE WESTERLY FLOW. MODERATE CONFIDENCE.**
KSFO BRIDGE APPROACH...SIMILAR TO KSFO.
MONTEREY BAY AREA TERMINALS...IFR THROUGH THE MORNING AT MRY WILL
GIVE WAY TO MVFR CONDITIONS WITH POSSIBLE VFR NOT OUT OF THE
QUESTION FOR THE AFTERNOON. KSNS IS CLEARING AND SHOULD STAY VFR THROUGH
THE AFTERNOON. IFR/MVFR CIGS FORECAST TO RETURN AROUND 03Z FOR
BOTH TERMINALS. WINDS MOSTLY UNDER 12 KT THROUGH THE PERIOD.
MODERATE CONFIDENCE.
&&
.MTR WATCHES/WARNINGS/ADVISORIES...
.TDAY...SCA...PT ARENA TO PIGEON PT 10-60 NM
SCA...PT ARENA TO PT REYES 0-10 NM UNTIL 2 PM
SCA...SF BAY FROM 2 PM
&&
$$

15.0 LLWAS Data

Low-level windshear alert system (LLWAS) data was provided around the time of the accident. The LLWAS wind data was captured every 10 seconds via the 10 LLWAS sensors located around KSFO (figure 14) and more information on the 10 LLWAS sensors' location is provided in attachment 2. The wind data around 1128 PDT is provided in table 9 below with the 10 second wind magnitude data in the first column of referenced sensor and the wind directions[29] in the second column of the referenced sensor.

[29] The wind directions are in reference to magnetic north.

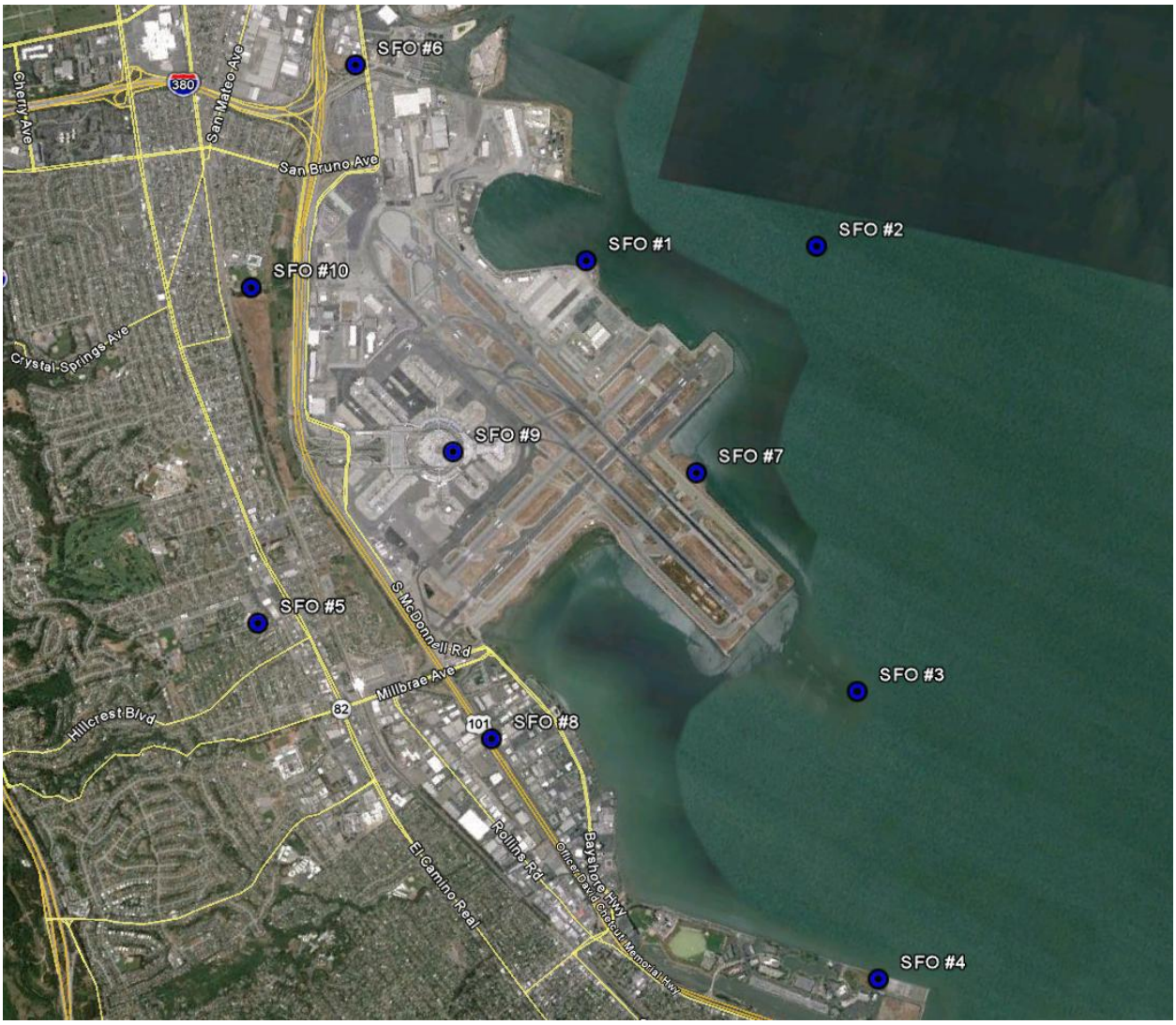


Figure 14 – Location of the 10 LLWAS sensors around KSFO

Date	Time (UTC)	Airport Wind (2min avg) and gusts			RS #1		RS #2		RS #3		RS #4		RS #5		RS #6		RS #7		RS #8		RS #9		RS #10	
		DIR	SPD	GUST	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD	DIR	SPD
7/6/2013	18:25:26	210	6	G00	233	7	277	2	999	99	208	10	220	8	171	5	214	2	163	10	256	7	187	9
7/6/2013	18:25:36	220	6	G00	237	7	265	3	999	99	196	10	216	7	176	5	193	3	164	10	244	7	188	10
7/6/2013	18:25:46	220	5	G00	242	6	268	3	999	99	189	12	213	9	186	4	186	5	164	11	245	6	189	10
7/6/2013	18:25:56	220	5	G00	246	5	268	3	999	99	181	12	201	11	183	4	188	5	165	10	241	6	178	10
7/6/2013	18:26:06	220	5	G00	255	5	272	3	999	99	183	11	203	11	174	6	195	5	159	9	247	7	173	8
7/6/2013	18:26:16	220	5	G00	260	4	274	2	999	99	190	10	200	7	178	7	194	4	163	9	251	7	181	10
7/6/2013	18:26:26	210	5	G00	262	4	271	3	999	99	203	8	188	6	173	6	190	6	164	10	250	6	179	10
7/6/2013	18:26:36	210	5	G00	268	4	268	3	999	99	185	7	187	4	170	5	166	7	162	9	250	7	175	9
7/6/2013	18:26:46	210	5	G00	262	3	268	3	999	99	177	6	203	6	185	7	157	7	163	9	234	7	180	10
7/6/2013	18:26:56	190	5	G00	258	4	262	3	999	99	196	4	205	10	196	8	153	6	159	9	227	7	187	9
7/6/2013	18:27:06	190	5	G00	263	4	258	4	999	99	192	5	207	11	191	7	159	5	161	9	235	8	191	9
7/6/2013	18:27:16	180	5	G00	260	4	237	4	999	99	207	7	205	10	190	8	161	5	163	9	233	8	185	8
7/6/2013	18:27:26	180	5	G00	253	4	234	7	999	99	213	8	206	11	182	7	158	6	168	9	229	8	178	8
7/6/2013	18:27:36	170	5	G00	253	4	237	7	999	99	195	10	210	11	187	4	171	5	168	9	231	8	186	7
7/6/2013	18:27:46	170	5	G00	251	4	234	7	999	99	190	13	212	11	184	4	165	4	162	9	244	8	188	8
7/6/2013	18:27:56	170	5	G00	248	4	233	8	999	99	194	10	213	12	178	4	162	3	156	8	238	5	186	7
7/6/2013	18:28:06	170	5	G00	225	3	232	7	999	99	193	8	215	12	179	3	174	3	161	8	251	7	187	9
7/6/2013	18:28:16	170	5	G00	233	1	237	8	999	99	208	8	214	11	172	4	183	3	159	8	248	7	189	10
7/6/2013	18:28:26	170	5	G00	215	2	239	8	999	99	201	9	212	10	176	6	178	4	168	7	240	7	198	10
7/6/2013	18:28:36	170	5	G00	190	4	240	7	999	99	201	10	213	9	174	7	183	5	166	8	247	7	194	10
7/6/2013	18:28:46	170	5	G00	187	5	242	7	999	99	203	12	225	9	176	7	173	5	165	8	251	7	187	9
7/6/2013	18:28:56	170	5	G00	189	5	244	7	999	99	206	12	215	8	179	7	173	5	169	8	251	7	189	9
7/6/2013	18:29:06	170	4	G00	178	5	250	6	999	99	202	14	216	8	180	7	161	5	180	8	247	6	188	9
7/6/2013	18:29:16	170	4	G00	174	6	252	7	999	99	215	13	198	8	177	7	158	5	177	7	242	6	194	8
7/6/2013	18:29:26	170	4	G00	175	6	252	6	999	99	213	12	208	10	175	7	159	4	173	8	246	7	195	9
7/6/2013	18:29:36	170	4	G00	187	7	248	6	999	99	196	10	210	11	178	8	163	4	183	8	246	6	195	9
7/6/2013	18:29:46	170	4	G00	187	6	246	7	999	99	196	9	207	10	173	8	162	4	177	8	247	6	188	8
7/6/2013	18:29:56	170	4	G00	199	6	245	6	999	99	194	11	206	9	174	8	175	4	170	8	249	6	192	6
7/6/2013	18:30:06	170	4	G00	196	5	249	6	999	99	191	12	218	9	175	8	179	4	178	9	251	7	197	8
7/6/2013	18:30:16	170	4	G00	188	6	248	5	999	99	199	10	216	10	172	8	189	4	172	8	246	7	189	9
7/6/2013	18:30:26	170	4	G00	185	6	250	4	999	99	202	9	210	11	175	9	171	3	169	7	235	6	187	9
7/6/2013	18:30:36	170	4	G00	179	6	244	4	999	99	192	10	216	11	174	10	190	4	168	7	248	5	187	10
7/6/2013	18:30:46	170	4	G00	176	6	239	4	999	99	193	10	212	10	172	8	176	5	177	7	246	5	191	9
7/6/2013	18:30:56	170	4	G00	177	6	238	5	999	99	194	13	216	10	177	9	161	4	166	7	247	6	187	10
7/6/2013	18:31:06	170	4	G00	180	6	239	4	999	99	188	12	217	9	155	8	162	5	156	6	235	7	188	10
7/6/2013	18:31:16	170	4	G00	182	6	252	4	999	99	188	10	221	8	162	8	160	3	161	6	251	7	188	9
7/6/2013	18:31:26	170	4	G00	178	6	256	6	999	99	185	9	210	7	169	9	158	3	157	7	251	7	193	7
7/6/2013	18:31:36	170	4	G00	177	5	251	6	999	99	177	8	197	9	167	7	165	3	169	9	237	8	196	8
7/6/2013	18:31:46	170	4	G00	179	4	248	5	999	99	187	6	192	8	160	8	157	2	174	9	239	9	196	6
7/6/2013	18:31:56	170	4	G00	183	4	239	4	999	99	181	6	193	8	152	8	172	2	161	9	248	7	191	6
7/6/2013	18:32:06	170	4	G00	188	4	248	4	999	99	190	8	191	9	152	8	163	4	169	10	258	6	213	5

Table 9 – LLWAS data around the 1128 PDT accident time

At 1128:06 PDT, LLWAS sensor # 7 reported the 10 second wind from 174° at 3 knots.

At 1128:16 PDT, LLWAS sensor # 7 reported the 10 second wind from 183° at 3 knots.

At 1128:26 PDT, LLWAS sensor # 7 reported the 10 second wind from 178° at 4 knots.

At 1128:36 PDT, LLWAS sensor # 7 reported the 10 second wind from 183° at 5 knots.

At 1128:46 PDT, LLWAS sensor # 7 reported the 10 second wind from 173° at 5 knots.

At 1128:56 PDT, LLWAS sensor # 7 reported the 10 second wind from 173° at 5 knots.

At 1128:06 PDT, LLWAS sensor # 4 reported the 10 second wind from 193° at 8 knots.

At 1128:16 PDT, LLWAS sensor # 4 reported the 10 second wind from 208° at 8 knots.

At 1128:26 PDT, LLWAS sensor # 4 reported the 10 second wind from 201° at 9 knots.

At 1128:36 PDT, LLWAS sensor # 4 reported the 10 second wind from 201° at 10 knots.

At 1128:46 PDT, LLWAS sensor # 4 reported the 10 second wind from 203° at 12 knots.

At 1128:56 PDT, LLWAS sensor # 4 reported the 10 second wind from 206° at 12 knots.

16.0 Camera Image Data

A camera located near the KSFO terminal was recording and had images from around the accident time. Figure 15 reveals an image of the accident aircraft while on final just above the runway. None of the few clouds at 1,600 feet agl reported from KSFO (section 3.0) were located on final approach or near the east end of the KSFO airport.

Figure 15 – Image from a camera near the KSFO terminal just before the accident time

17.0 Pilot Weather Briefing Dispatch

The weather briefing information from dispatch is provided as attachment 1. It contained all the standard information, including TAFs for KSFO and alternates, wind aloft information, SIGMETs valid for the route of flight, whether or not any AIRMETs were valid, whether or not any volcanic ash advisories were valid, etc... For more information please see attachment 1.

18.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on July 6, 2013, indicated the following:

SUN	
Begin civil twilight	0523 PDT
Sunrise	0554 PDT
Sun transit	1315 PDT
Sunset	2035 PDT
End civil twilight	2106 PDT

F. LIST OF ATTACHMENTS

Attachment 1 – Weather Briefing Information from Dispatch

Attachment 2 – Location Data of the 10 LLWAS sensors around KSFO

Paul Suffern
NTSB, AS-30